



Outbreak of *Mycobacterium tuberculosis* Among Employees of an Elephant Refuge

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Communicable and Environmental Disease Services



**Centers for Disease
Control and Prevention**
Office of Surveillance, Epidemiology,
and Laboratory Services



The Outbreak

- Notification
 - October 2009
 - 5 tuberculin skin test (TST) conversions among employees of an elephant refuge
- Refuge
 - Known to house elephants previously exposed to *Mycobacterium tuberculosis*
 - Rumors that one elephant had tuberculosis disease

Tuberculosis (TB)

- Caused by *Mycobacterium tuberculosis* (Mtb)
- Spread on airborne droplet nuclei
- Transmitted during close, prolonged contact

TB in Humans and Elephants: Inactive Infection

	Humans	Elephants
Detection method		
Symptoms		
Infectious to others		
Preventive therapy		

TB in Humans and Elephants: Inactive Infection

	Humans	Elephants
Detection method	Positive TST or IGRA	
Symptoms	No	
Infectious to others	No	
Preventive therapy	Recommended	

TB in Humans and Elephants: Inactive Infection

	Humans	Elephants
Detection method	Positive TST or IGRA	Validation needed
Symptoms	No	No
Infectious to others	No	Probably not
Preventive therapy	Recommended	Efficacy unknown

TB in Humans and Elephants: Active Disease

	Humans	Elephants
Diagnosis		
Symptoms		
Infectious to others		
Treatment		

TB in Humans and Elephants: Active Disease

	Humans	Elephants
Diagnosis	Sputum or chest x-ray	
Symptoms	Yes	
Infectious to others	Yes	
Treatment	Required	

TB in Humans and Elephants: Active Disease

	Humans	Elephants
Diagnosis	Sputum or chest x-ray	Saline trunk wash
Symptoms	Yes	Rare
Infectious to others	Yes	Yes
Treatment	Required	Recommended; efficacy unknown

TB in Humans and Elephants: Treatment for Disease

	Humans	Elephants
Antibiotics		
Duration		
Delivery		
Efficacious		

TB in Humans and Elephants: Treatment for Disease

	Humans	Elephants
Antibiotics	Isoniazid, rifampin, ethambutol, pyrazinamide	
Duration	6 months	
Delivery	Oral	
Efficacious	Yes	

TB in Humans and Elephants: Treatment for Disease

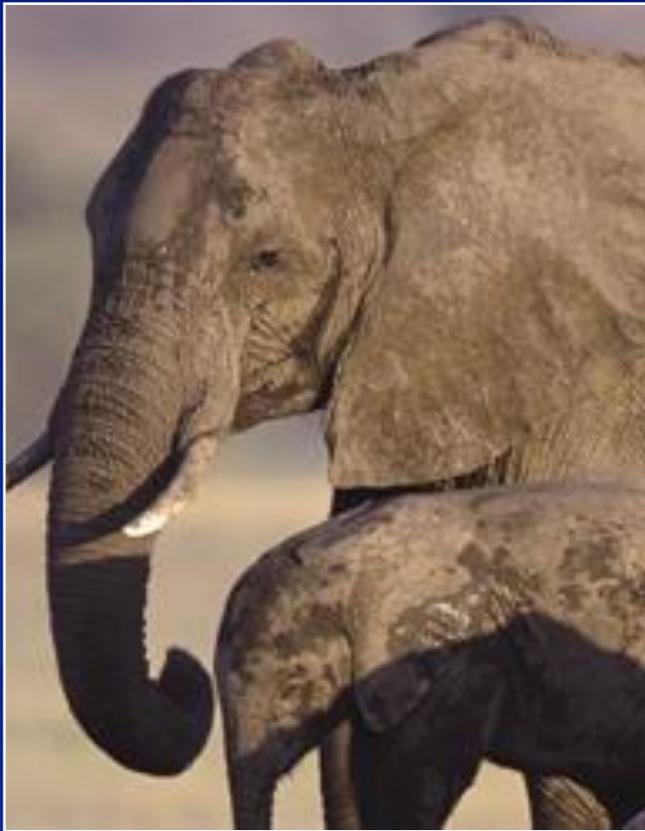
	Humans	Elephants
Antibiotics	Isoniazid, rifampin, ethambutol, pyrazinamide	Isoniazid, rifampin, ethambutol, pyrazinamide
Duration	6 months	12 months
Delivery	Oral	Oral or rectal
Efficacious	Yes	Unknown

Important Literature

- 1998 Michalak et al. (EID)
 - TB outbreak among 4 elephants in Illinois
 - One employee had TB — isolate matched the elephants
 - 11 employees positive TST — timing of conversion unknown
 - Prompted action from USDA — annual *Mtb* testing required

Captive Elephants in North America

220 African elephants
2% infected with *Mtb*



270 Asian elephants
12% infected with *Mtb*



Elephant Refuge in Tennessee

- Established in 1995 with 1 elephant
- Care of sick, old, or abused elephants
- Nonprofit organization
- Accredited and licensed
- Closed to the public

Elephant Refuge in Tennessee

- 2,700 acres and 14 elephants
- 3 areas with a barn and dedicated staff
 - African area — 2 African elephants
 - Asian area — 6 Asian elephants
 - 3 from Illinois herd
 - Quarantine area — 7 Asian elephants
 - All from Illinois herd

They loaded up their trunks and they moved to Tennessee...







The Outbreak

- Notification
 - October 2009
 - 5 TST conversions
 - 1 elephant with TB
- Response
 - Gained access to the refuge
 - Initiated onsite investigation
 - December 2009

Investigation Objectives

- Determine extent of outbreak
- Identify risk factors for TST conversion in humans
- Prevent ongoing transmission

Cohort Study

- Interviews
- Occupational health records
 - Preemployment and annual TST results
 - Respirator fit testing dates
 - Employment dates
- TST screening increased to quarterly

TST Conversion

- Refugee employee or intern
- 2006–2009
- Documented negative (<10 mm) TST
- ≥ 10 mm increase in TST induration within 2 years

Onsite Assessment

- Barn management
- Elephant husbandry practices
- Environmental sampling in targeted areas
- CDC National Institutes of Occupational Safety and Health (NIOSH)

Record Review

- Refuge and TN Wildlife Resources Agency (TWRA)
- Timeline of events
 - Elephants
 - Employees
- *Mtb* culture results for respiratory secretions
 - Trunk wash
 - Participating elephants

Employee Cohort, 2006–2009

- 57 current and former employees
- 46/57 (81%) interviewed
 - 30 caregivers
 - 11 administrators
 - 5 maintenance workers
- 9/46 (20%) had positive TST

Characteristics of Employees with Positive TST (n=9)

- 7 female
- Mean age 40 years (range 25–62 years)
- TST ranged 12–24 mm induration
- 1 conversion in 2006
 - Prolonged exposure to a known source of TB
- 8 with documented conversion in 2009
- 6 began preventive therapy
- None have active TB disease

Potential Risk Factors for TB Among Refugee Employees, 2006–2009

Potential risk factor	Exposed			Unexposed			Relative Risk (95% CI)
	TST+	Total	%	TST+	Total	%	
International travel	5	19	26	4	27	14	1.8 (0.6–5.8)
Foreign-born	2	6	33	7	40	18	1.9 (0.5–7.1)
Exposure to person(s) with TB	0	4	0	9	42	21	–
Healthcare facility work	1	8	13	8	38	21	0.6 (0.1–4.1)
Correctional facility work	0	4	0	9	42	21	–
Homeless shelter work	0	1	0	9	45	20	–

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Close elephant contact	2	11	18	7	35	20	0.9 (0.2–3.8)

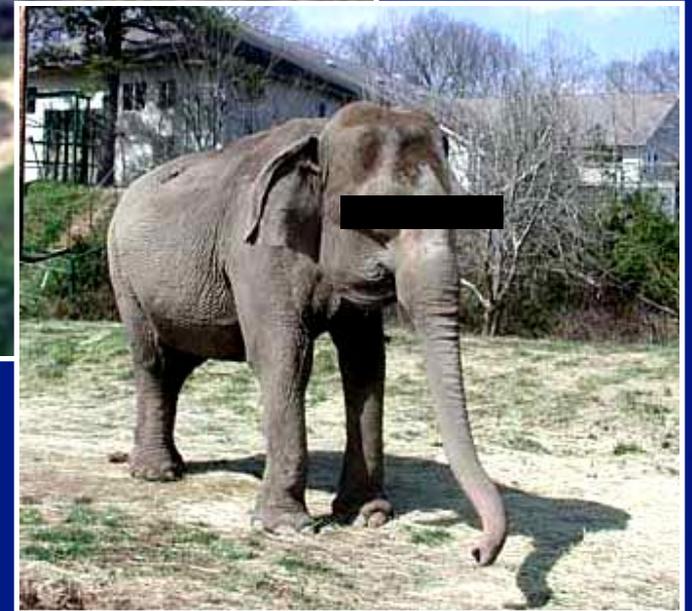
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Quarantine area exposure 2009	8	13	62	1	33	3	20.3 (2.8–146.7)

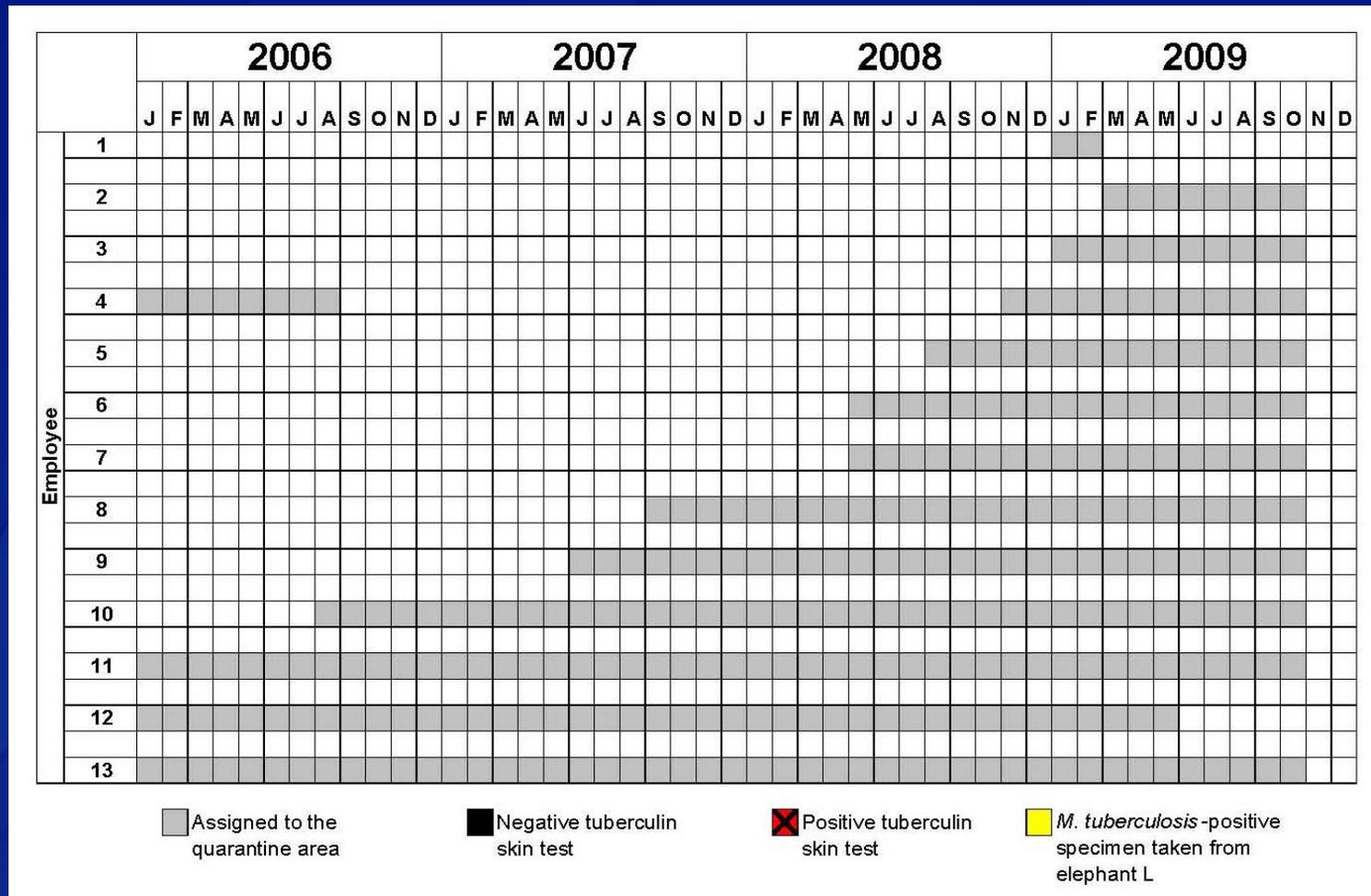
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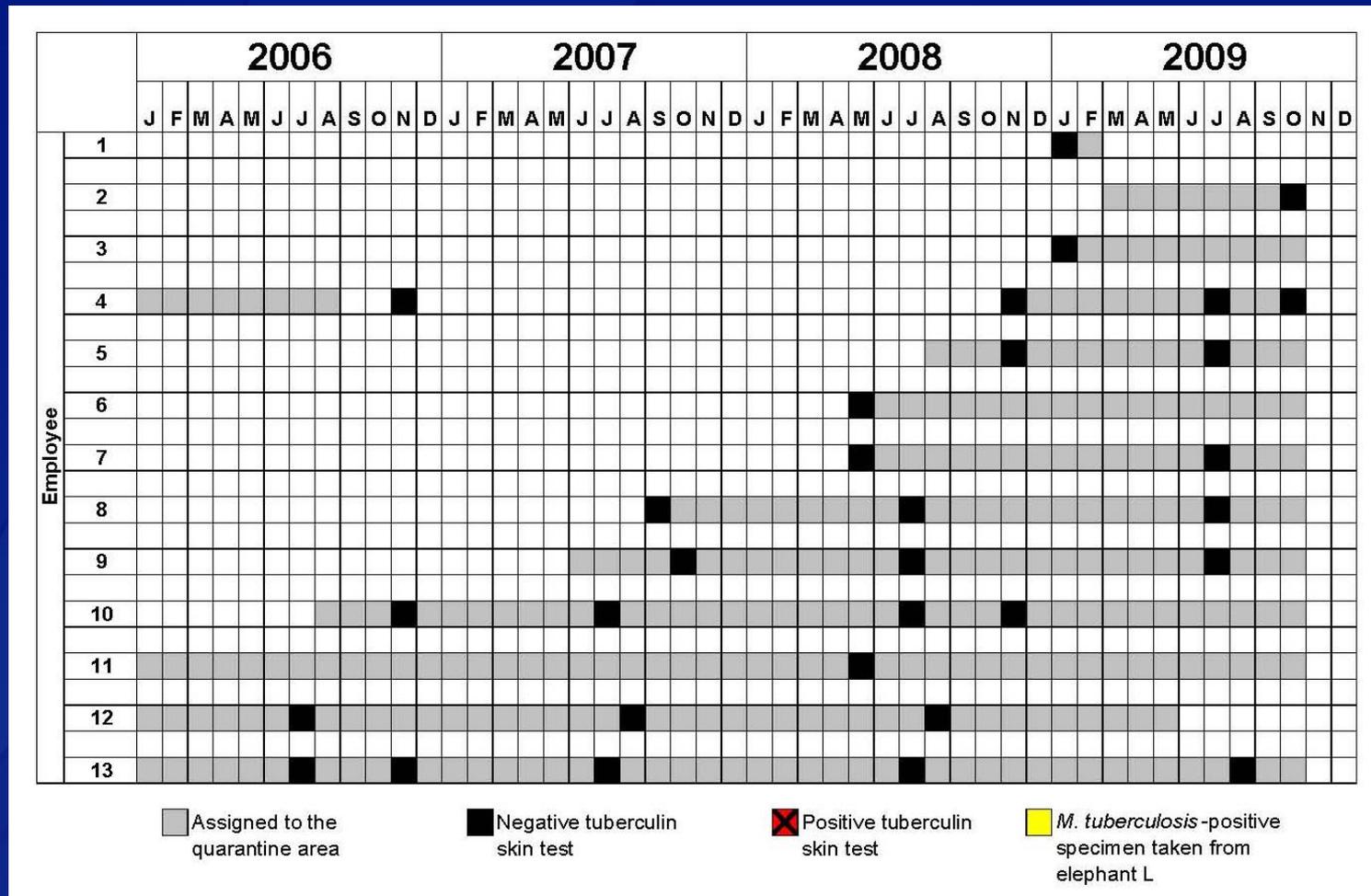
Quarantine Area



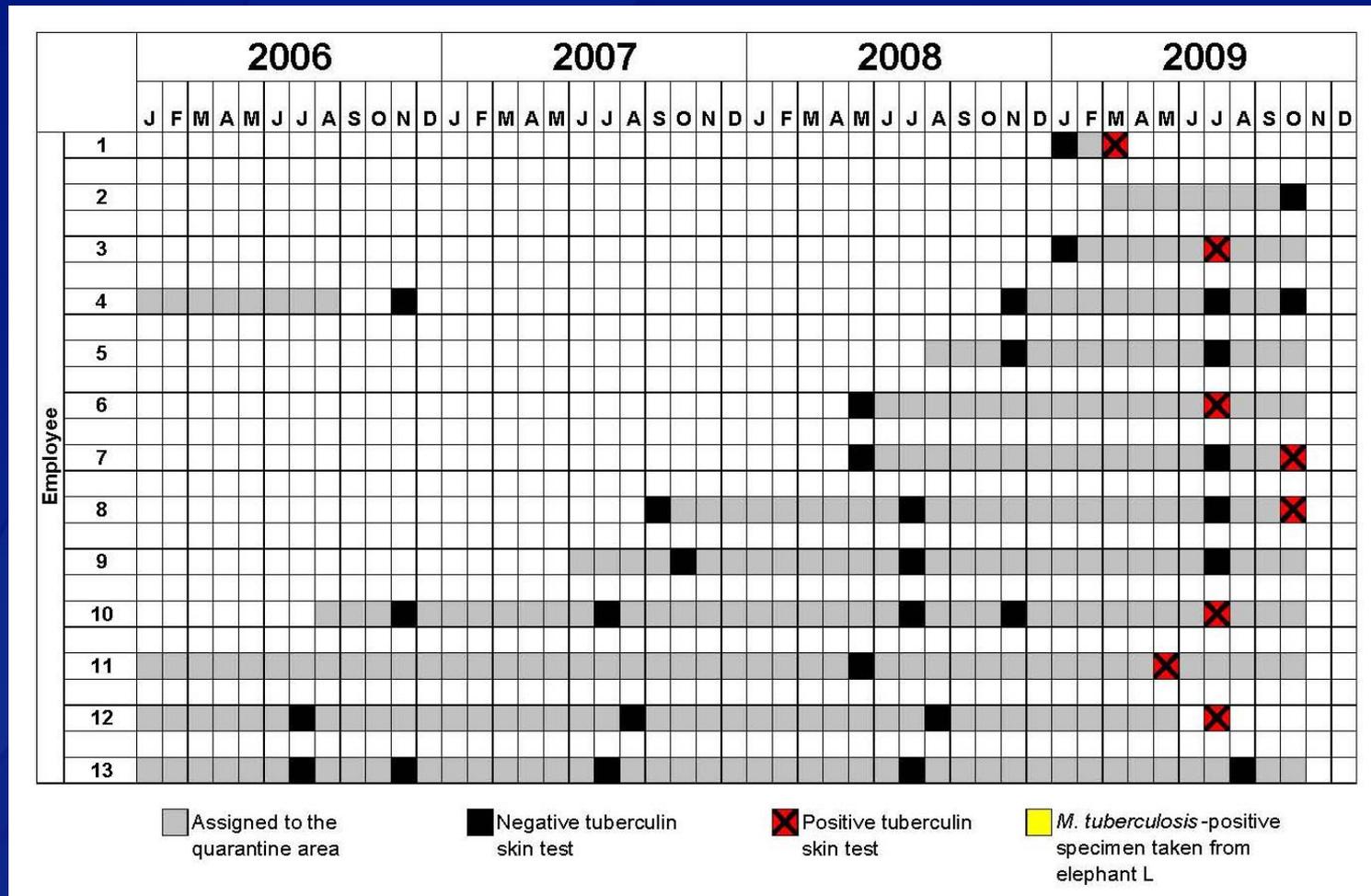
TST Conversion Timeline Among Quarantine Area Employees, 2009



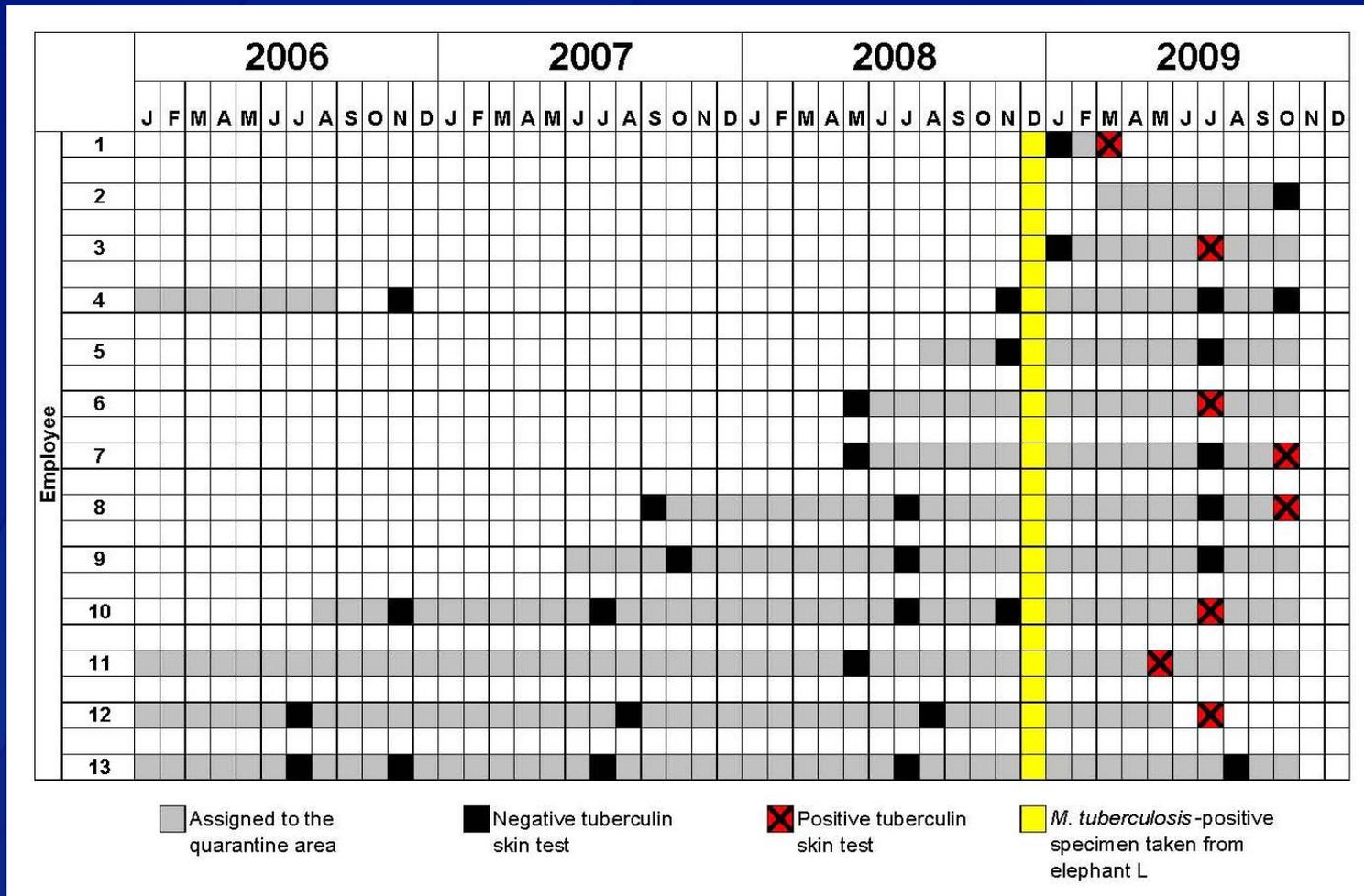
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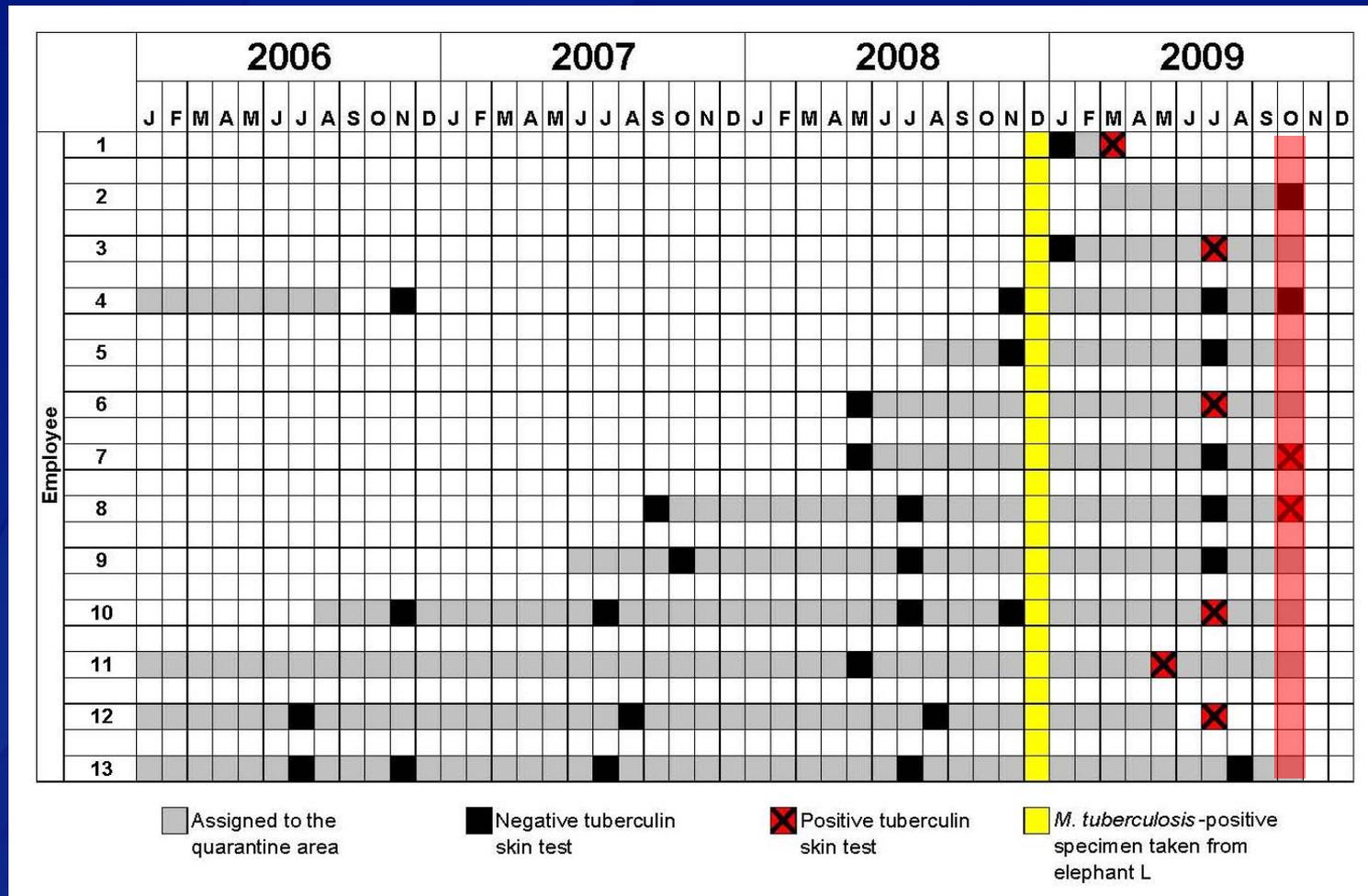
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Characteristics of Quarantine Area Employees, 2009 (n = 13)

	Conversion (n = 8) No. (%)	TST Negative (n = 5) No. (%)
Position		
Caregiver	5 (63)	3 (60)
Administrative	3 (38)	0 (0)
Maintenance	0 (0)	2 (40)
Close contact with elephant(s)	1 (13)	2 (40)
Participated in elephant(s) trunk wash	0 (0)	1 (20)
Pressure washed	5 (63)	3 (60)
Annual N95 fit testing	2 (25)	3 (60)
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High Risk Work Practices



Unrestricted Air Flow



Environmental Sampling

- Barn housing the *Mtb*-infected elephant
- Standard methods
- *Mtb* not isolated
 - Elephant stool (n = 14)
 - Water (n = 12)
 - Barn surface swabs (n = 23)
 - Air filter (n = 3)
- *M. fortuitum* isolated from 6 specimens



More on Elephant L

Mtb Culture Isolation

- Transferred from Illinois herd in 2006 and housed in quarantine
- Respiratory secretions obtained by trunk-wash method annually
- *Mtb* culture-positive in 2009
 - Susceptible to all 4 first-line antibiotics
 - *Mtb* genotype PCR01621
 - 2004 CA human patient
 - 2005 TN elephant died with TB (Illinois herd)
 - 2006 TN elephant died with TB (Illinois herd)
 - 2008 MO elephant

Summary

- Employees exposed to the quarantine area in 2009 were 20 times more likely to have TB infection
 - RR 20.3; 95% CI 2.8–146.7
- 8 TST conversion documented in 2009
 - 3 administrators without elephant contact

Factors Contributing to Transmission

- Delayed response to *Mtb* isolation
- Inadequate infection control
 - Aerosol-generating work practices
 - Inconsistent use of respirators
 - Unrestricted air flow

Immediate Interventions

- Relocate nonessential personnel
- Increase use of respirators
- Revise infection control practices

Limitations

- 11 former employees not contacted
 - None employed during 2009
 - 2 employed during 2008

Conclusions

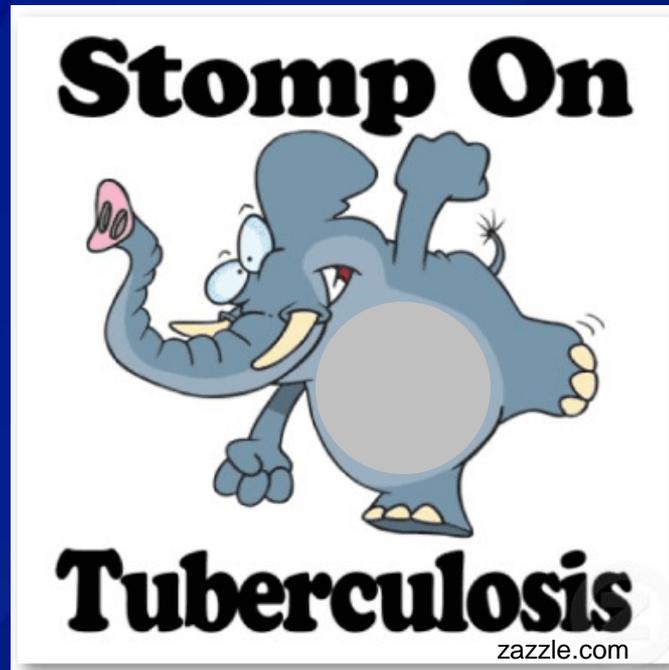
- *Mtb* transmitted from elephant to humans
 - Elephant L source of *Mtb*
- Indirect exposure associated with *Mtb* infection
- Inadequate infection control practices contributed
- Immediate interventions implemented

Recommendations

- Reduce aerosol-generating work practices and restrict unfiltered air flow
- Educate workers and provide a comprehensive occupational health program
- Develop and comply with evidence-based TB control guidelines to protect employees working in the elephant industry
- Improve methods for diagnosis and treatment of *Mtb* infection in elephants

Acknowledgments

- Elephant refuge
 - Employees
 - Leadership
- Tennessee Wildlife Resources Agency
 - Walter Cook
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 - William Schaffner
- CDC EIS Field Assignments Branch
 - W. Randolph Daley
 - Diana Bensyl
 - Kris Bisgard
- CDC Division of TB Elimination
 - Maryam Haddad
 - Adam Langer



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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.



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EXTRA SLIDES

New Serologic Assays for Detecting *Mtb* Exposure in Elephants

- ElephantTB STAT-PAK®
 - Lateral-flow technology
 - Detects reactive antibody to *M. tuberculosis* and *Mycobacterium bovis* antigens
 - Simple, rapid, and can be performed onsite
- MAPIA (multiantigen print immunoassay)
 - Detects reactive antibodies in serum specimens
 - After a STAT-PAK-positive result, MAPIA has been used as a confirmatory test for *M. tuberculosis*
 - Monitoring the treatment of elephants with active TB

Important Literature

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 - TB outbreak among 4 elephants in Illinois
 - One employee had TB — isolate matched the elephants
 - 11 employees positive TST — timing of conversion unknown
 - Prompted action from USDA — annual *Mtb* testing required
- 2002 Oh et al. (EID)
 - TB infection among multiple species at California zoo
 - 55 employees positive TST — 10 with probable conversion

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Culture Isolation of *Mtb* from Elephant Respiratory Secretions

- Obtained by trunk-wash method
 - 30–60 mL of saline
 - Raise then lower trunk to collect saline
 - 3 samples collected over 1 week
 - Standard methods for mycobacterial species
- Method has low sensitivity
 - *Mtb* isolation confirms active TB disease
 - Negative result does not exclude active disease

Trunk Wash Collection



Trunk Wash Results

- Provided by TWRA
- 2006–2008, all trunk-wash results received were *Mtb* culture-negative
- 2009, *Mtb* isolated from 1 of 14 elephants
- Elephant L
 - *Mtb* culture-positive
 - Housed in quarantine area
 - Arrived in 2006
 - Transferred from Illinois herd

Elephant L Trunk Wash Timeline

- Dec 2008
 - Secretions collected
- Mar 2009
 - *Mtb* isolated
- Jul 2009
 - Culture confirmed
- Oct 2009
 - Heightened infection control



Elephant L Isolate

- *Mtb* susceptible to all 4 first-line antibiotics
 - Isoniazid, rifampin, ethambutol, pyrazinamide
- Genotype PCR01621
 - 2004 CA human patient
 - 2005 TN elephant died with TB
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